Searching, Finding, Reading, Understanding, and

The Challenges of Using Mars Mission Datasets for Science Analysis

USGS
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Astrogeology Research Program

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The "customer perspective"

- **Who are the customers (users) of mission data?**

  - Funded R&A PIs, Co-Is, Grad students, post-docs

  - Mission planners

  - Scientists interested in *proposing to use* the data for R&A programs

- **What are their goals?**

  - Detailed analyses

    - begin with raw data, calibrate it themselves, accurately correlate with surface features, other data sets, incorporate custom algorithms, etc.

  - Simple answers

    - does appropriate data exist for the region of interest?

    - what are standard characteristics of region of interest (altimetry, radiometry, composition…)

- **Mariner, Viking (lander, orbiter), Hubble**

- **Mars Pathfinder: IMP, APXS, ASI/MET**

- **Mars Global Surveyor: MOC, TES, MOLA, MAG/ER**

- **Mars Odyssey: THEMIS, GRS, NS, MARIE, HEND**

- **Mars Express: HRSC, OMEGA, MARSIS/ASPERA/SPICAM**

- **Mars Exploration Rovers: Pancam, Mini-TES, MB, APXS, MI, RAT, Navcam, Hazcam**

- **Mars Reconnaissance Orbiter: HiRISE, CRISM, CTX, MARCI, MCS, SHARAD**

- *Phoenix: RAD, MARDI, SSI, TEGA, MECA, MET*

- *Mars Science Laboratory: MastCam, MARDI, MAHLI, ChemCam, APXS, CheMin, SAM, DAN, RAD, REMS*

Where's the data?
Get thee to a PDS website….

http://pds.jpl.nasa.gov/

April 20, 2006

Or the Imaging Node….

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Or the Geosciences Node….
http://pds-geosciences.wustl.edu/

Typical end-user complaints about mission data products (L. Crumpler):

- **The released data cannot be "used" easily by non-mission scientists:**

  - Searches are stymied by data format challenges

  - Data are too "raw" to be useful….

    - data are organized/archived along mission timelines/orbits instead of spatial location

  - ...Or data are too highly processed (gridded, resampled) for users who wish to analyze "actual observations"

- **"Quick look" overviews of available data for particular regions require substantial time commitments**

  - MOLA: "There is not an easy way to find the right track, so a lot of time can be spent downloading a track that turns out to be not the one that is needed."

But there are *lots* of tools out there to locate and/or process data….

- **MOC**
  - MS^3: *http://www.msss.com/moc_gallery/*
  - USGS: *http://ida.wr.usgs.gov/*
- **THEMIS**
  - ASU---THMPROC *http://themis.asu.edu/* →
    http://themis.asu.edu/thmproc
- **MER: Analyst's Notebook:** *http://anserver1.eprsl.wustl.edu/*
- **Combined orbital data sets**
  - USGS---PIGWAD: *http://webgis.wr.usgs.gov*
  - ASU---JMARS: *http://jmars.asu.edu/*
  - Ames—MARSOWEB: *http://marsoweb.nas.nasa.gov/*

  - USGS---ISIS (map projections), UPC: *http://isis.astrogeology.usgs.gov/*
  - USGS---Map-a-Planet: *http://pdsmaps.wr.usgs.gov/maps.html*

Where's the software?

- **The increasing complexity of Mars datasets results in custom software (s/w) development by instrument teams that is often the only means to visualize/analyze data**

  - This s/w may be released at end of mission (but not always)

  - This s/w may be well documented/supported and available for a variety of platforms (but not always)

    - ISIS provides support for some (but not yet all) missions/data sets

  - Instrument/mission team s/w may require other proprietary tools to execute (e.g., IDL), but not always

    - Use of "virtual" IDL allows s/w use, but limited production ability (?)

  - Lack of this s/w results in redundant/complementary efforts to write tools necessary to visualize/analyze data

What's the problem?

- **Argument Style 1**

  - Mars state-of-the-art instruments (remote sensing, in-situ) produce unique datasets that are complicated. But there are lots of smart folks around who can deal with it.

  - Tools exist (or are in continuous development by missions and/or R&A folks) to search, quality-check, calibrate, spatially locate, and analyze many data sets.

  - If not, instrument documentation is always available to inform users how to work with the data.

  - Users need do their homework and learn how to work with complicated data sets.

  WHINING

J.R. Johnson, USGS

What's the problem?

- **Argument Style 2 (*more productive*)**

    - Complicated datasets have significant "learning curves" that limit effective and efficient use of the data to only the original instrument PI's team and/or mission teams.

    - This inhibits widespread community involvement in understanding/interpreting datasets vital to our understanding of Mars and the future of the Mars Exploration Program.

    - These "roadblocks" cause some potential researchers to forego proposals to R&A, Participating Scientist programs

        - "I thought about writing a proposal, but it I didn't have the time to become sufficiently fluent in all the datasets, so I bailed…."

So what are the solutions? (1)

- **Continue efforts toward synergizing data from multiple missions and making the data, s/w, derived products available in standardized, easily-accessible formats**

  - Expand/connect GIS-related servers

    - JMARS, PIGWAD, JPL, Google?

    - cf. Report of the Mars Environmental GIS Workshop, Oct. 5-6, 2005

  - Continue to advertise new tools via DPS/EGS/AGU/LPSC abstracts

  - Fund instrument teams to conduct workshops (on-line or in-person) for their instruments and datasets. It's **E**/PO!

    - TES, THEMIS have done this, others?

    - JMARS, ISIS already do this, too.

So what's the solution? (2)

- **Encourage release of "lite" versions of mission-related software prior to end-of-mission**

  - Mainly for "quick-look" use, not necessarily detailed analysis

  - Curtail necessity of proprietary (expensive) s/w packages → IDLV?

- **Missions need to have a cartographic planning component, and they should follow a consistent cartographic coordinate system and data format**

- **Planetary image data should be systematically processed in a coordinated way and made available in an easily accessed form (e.g., a GIS).**

- **But relatively small budgets permit only partial solutions – need to encourage increased funding.**

Promote Dataset Synergy (aka PDS)

Report of the Mars Environmental GIS Workshop, Oct. 5-6, 2005

http://mepag.jpl.nasa.gov/workshop/ (Dave Beaty)

- "GIS-ready" data that are easily used by researchers for display and analysis via Planetary Data Systems (PDS) or other
- Better defined processing steps for commonly used/requested data sets
- Easier tools/capabilities for processing raw data from each instrument into standard format(s)
- Provide validated/calibrated data in both raw and map projected formats
- Need improved data catalog / discovery capability whether the datasets reside at a centralized entity or individual research facility

System Architecture

Need to identify / define / develop these components

PDS

Other sources

Standard Formats

Standard Interface

Generic Processing Software (e.g., GIS)
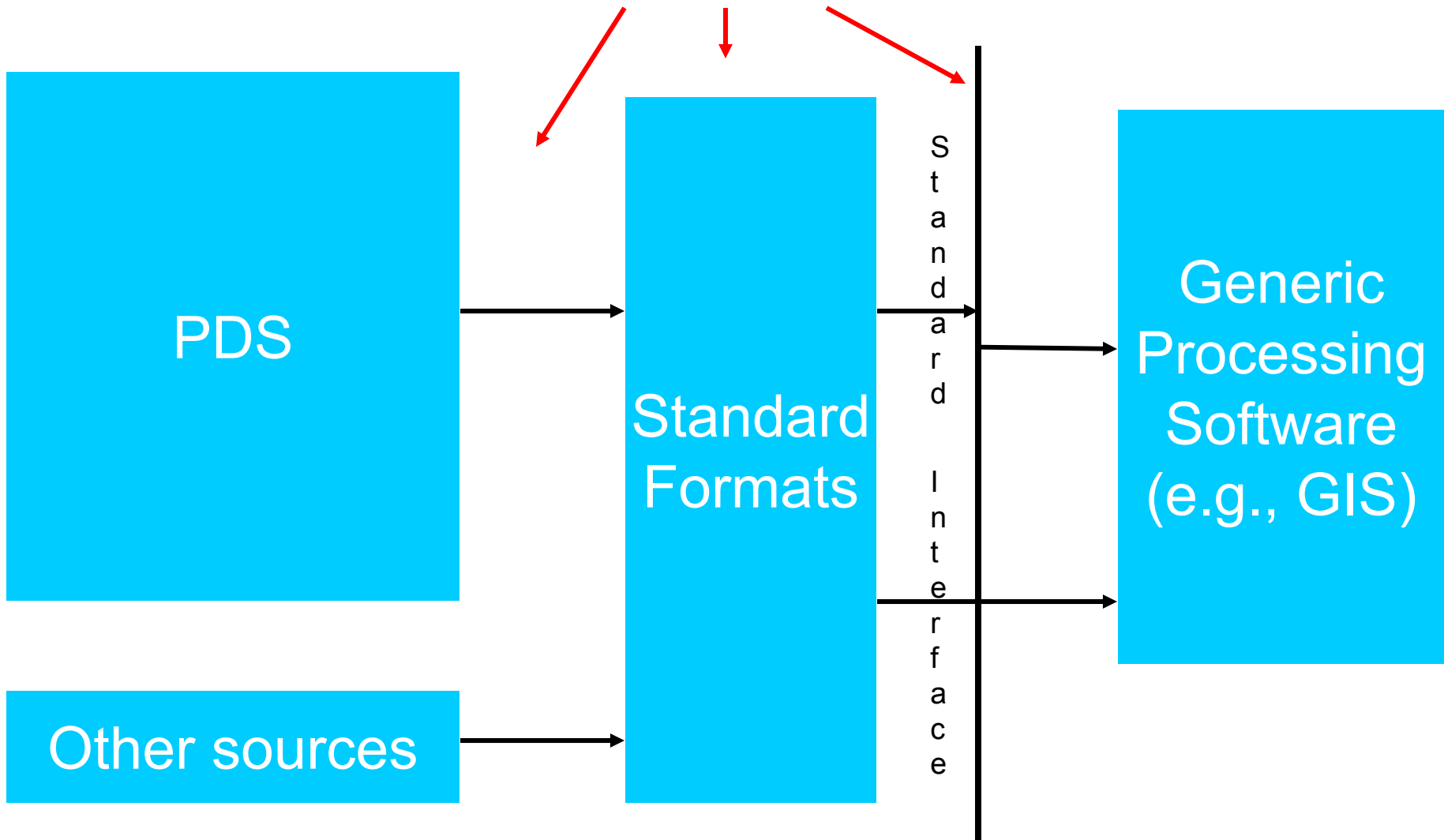
Report of the Mars Environmental GIS Workshop, Oct. 5-6, 2005

GIS Recommendations (cont)

Report of the Mars Environmental GIS Workshop, Oct. 5-6, 2005

- Provide "on-line services" to help process datasets that are not easily derived as a single final product (e.g., MOC narrow angle, THEMIS visible images).

- Work with future mission planners to "task" instruments and define processing steps to meet geodetic standards

- Develop outreach activities to educate the planetary community about the benefits of:
    - GIS software* for spatial analyses
    - Community-supported data formats

- *i.e., geospatial applications in general, preferably those that can share datasets

- "*One application will simply not work for everyone.*" The goal is to standardize the formats and/or data distribution mechanisms to allow many applications to utilize the same data in different ways. ---*Trent Hare*